Chapter – 1

Introduction

(Section-A)

1.0 Introduction

Energy is integral part in the industrial & economy development in particular and social development in general. For every industrial, business as well as social process, energy is essentially needed for their developments, creation of new values and or accomplishment of things. Hence, energy or energy production in the form of electricity has a direct impact on the industrial, commercial, social and economic development of every country in the worlds.

In view of which, one can say that electricity industry has a major foot print to shape the development pattern of any country in the world. The worldwide economic scenarios presently turn over to the radical changes in innovative technological up gradation with the sophisticated development of Industrial organisations which ultimately needs the uninterrupted continuous source of electricity for sustainable growth and development. The country having developed, efficient and sustainable energy sector with uninterrupted secure energy supply, almost negligible impact on environment and at the same time available at reasonable prices of energy resources, results in multilateral growth of that country with competitive effect.

Electricity is not limited to the sustainable growth and development of any industries but also supports for sustainable growth & development of agriculture, transports, communications,

It is envisaged that energy consumption all over the world has been continue increasing at comparatively faster rate due to increased population and socio-economic development.

As per **Emrah Kocak and Aykut Sarkgunesi (2017)** `` there is positive long run relationship between renewable project energy consumption and economic growth. The author studied nine countries of Black Sea & Balkan countries for the period 1990-2012.

Adrienne Ohler and Ian Fetters (2014) ``studied the relationship between electricity generation form renewable energy projects and economic growth

for 20 OECD countries for data covering the period 1990 – 2008.`` As per Ohler and Fetters (2014) `` renewable energy generation hold important roles in future energy consumption and economic prosperity and subsequently lead to a faster transition towards a developed society in long run``

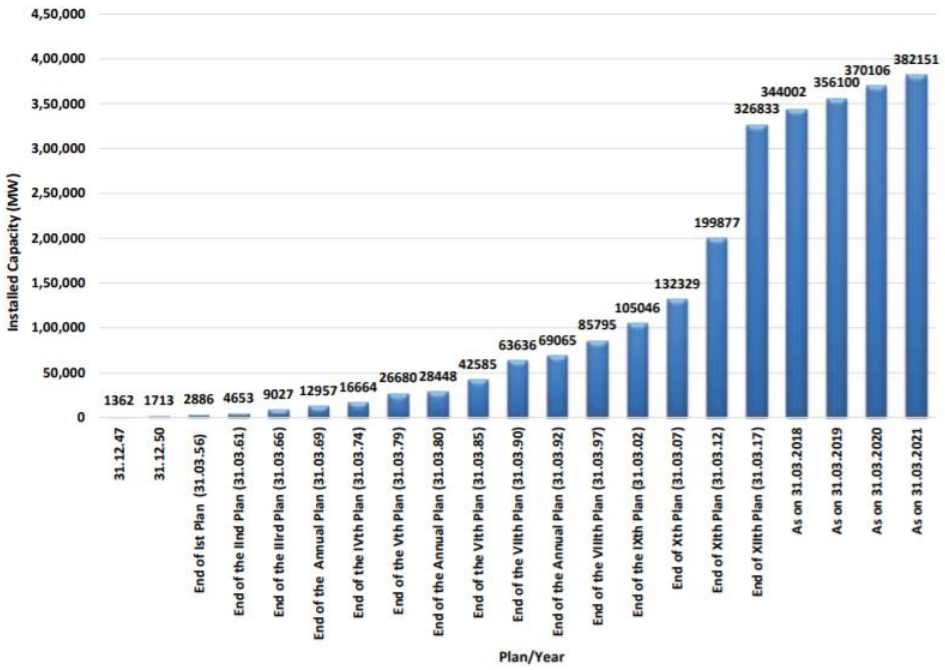
1.1 Energy Scenario of India:

As per IBEF, August 2020 (India Brand Equity Foundation), an arm of the Indian government's ministry of commerce and Industry. ``**India is the third largest producer of electricity** as well as the **Second largest consumer of electricity in the world**. Moreover, the India is the **fifth largest installed power capacity in the world**. As per **CEA report December 2021** (Central Electricity Authority), ``the total installed power capacity reaching to 393.389GW out of which renewable energy project capacity reaching to 104.878GW includes solar project capacity of 49.346GW and 40.082GW of wind project capacity.``

The plan wise utilities installed capacities in India since 1947 indicates low capacity growth up to 1985 as depicted in graph vide **CEA, 2021** yearly Report ``Growth of Electricity Sector in India from 1947 to 2021.`` Since independence of India, country has undergone remarkable progress in installed capacities. During independence 1947, there was installed capacity of only 1.362GW.

Accordingly, there is low capacities growth up to end of the Vth plan annual year 1980. Subsequently there is faster growth in installed capacities recorded from 1980 - 28.5GW to 199.88GW in year 2012. The installed capacity further rises rapidly from year 2017 and it reached to 382.151 GW till the end of March 2021.

Graph-1.1: Installed capacity growth of India since 1947



Source: CEA Report April 2021

Since independence, the electricity installed capacities has grown up more than 300-fold, growth in demand has been even higher due to accelerated economically growing activity.

Thus, Indian power sector is undergoing a massive change that has redefined economic and industrial growth in sustainable manner with maintaining their growth continuously to meet Indian electricity demand in future. This has been envisaged through the government of India`s drive for 24x7 affordable and quality **'Power for all'** in the country by March 2019, which further intend to accelerate capacity addition and adequate necessary infrastructure in the country.

1.2 Understanding Renewable Energy:

Since the research projects undertaken relates to the renewable energy projects, it felts necessary to have clear information, knowledge and understanding about the development and acceleration of renewable energy industry in world, particularly in India. In this context, a brief overview on renewable energy, its growth, perspectives and future development is described herein.

In broad term, the main energy resources are divided into two categories called non-renewable energy and renewable energy

The term ``**Renewable Energy**`` is exactly what it sounds that **`energy which can be renewed`.** Unlike other fossil fuel like oil, coal or gas which can`t be renewed and be a limited sources.

Renewable energy also termed as ``**Alternate Energy**`` or ``**Green Energy**`` or ``**Clean Energy**``, resources are unlimited natural resources that can be abundant does nor deplete the natural resources and replenished in a shorter period of time, which creates very little to no environmental pollutions during the process of its production or utilization. The history evident than in past, even after such comparable benefits of renewable sources of energy, the utilization of natural resources are not being explored to the possible extent, might be due to its unique challenges posed by the green sources of energy. **Brett Smith, B.A., 2019** ``reported that Renewable energy faces major hurdles of wider adoption, various renewable energy technologies, the modern realities of the marketplace, regulations and infrastructure``. The challenges however can be converted into opportunities to harvest the natural pollution free resources in a maximum potential for the universe at large. The utilization and consumption of such natural renewable sources of energy is possible with the help of specialized equipment, efficient and cost effective technological development and exclusive support in the form of capital subsidy, financing, proper supply chain mechanism, transmission infrastructure, favourable policy and regulations by the government to promote the investors in the renewable sector for establishment of large utility scale of renewable energy projects particularly ``on grid solar photovoltaic power projects`` and ``on shore wind energy power projects``` at competitive rate of production and operation in India as well as globally.

1.3 Defining Renewable Energy:

As per Draft National Renewable Energy Policy 2015 **(MNRE,GoI, 2015)** ``Renewable Energy (RE) Sources defined as energy derived from non-depleting resources, which includes the following sources:

1) Wind
2) Solar radiation (Photovoltaic & solar thermal)
3) Mini hydro
4) Biomass
5) Biofuels
6) Landfill & Sewage gas
7) Municipal solid waste
8) Industrial waste
9) Geothermal energy
10) Ocean energy
11) Any other energy source, notified by the Ministry; and
12) Hybrids of above sources

Hence, the basic sources of renewable energy include the wind, the solar, the heat at the earth's crust, the gravitational force of the earth, the ocean waves & tides, the landfill gases, and to a limited extent, animals and plant material. Most of these sources of renewable energy are directly utilized in the natural raw form.

1.4 Renewable Energy Sources:

The various forms of renewable energy sources are depicted here under:

Solar Energy: Solar Energy is one of the most popular types of renewable energy in the world. The sun radiates light and the energy is harvested from the light, the energy is harvested directly from sunlight's with the use of solar panels and converted it to electricity. The solar radiation produces as much as energy that the amount of sun lights in the form of radiation reaches to earth in a single hour could meet the energy demand of the whole world for an entire year. Out of total suns energy about one third of the sun lights reflect back to the space and some of them is absorbed by our atmosphere. The sun light, the form of radiation contains about 1300 watts of power per square metre area.

Wind Energy: The wind is feel due to uneven heating of Earth`s surface the power of wind is captured with the help of wind turbine, which rotates due to wind flow and generates electricity. Wind turbines now a day, increasingly popular for the utility scale of operation.

Hydro Energy: Just like generation of energy through flow of air, the hydro electricity generated through flow of water with the use of turbine, rotation of which produces electricity.

Geothermal Energy: The geothermal energy is derived from the heat of the earth as the earth has a massive energy sources inside it. The tremendous heat is also generated from radioactive decay in rocks beneath the crust. The geothermal energy captured by using steam from heated water which ultimately rotates the turbine to generates electricity.

Biomass Energy: Biomass energy refers to that energy which produces from recently living organic maters like plants, animals etc. The biomass can be said to be a renewable energy sources because the plants can be regrown comparatively quickly and that is also with the energy of sun.

Tide & wave Energy: Altogether, it is referred as the SUN is said to be the universal and most powerful source of Renewable Energy because most of the renewable energy sources are either directly or indirectly derived from the sun such as photovoltaic and solar thermal. The other renewable energy sources such as wind energy, hydro energy, photosynthesis solar energy conversion into biomass or from environmental natural turbulence such as geothermal, tidal & wave energy are indirectly deprived from sun or solar energy

Out of all types of renewable energy, solar and wind are the most popular and abundant sources of renewable energy and widely used in the utility scale renewable energy projects.

1.5 Exceptional benefits of Renewable Energy Projects:

The renewable energy (RE) offers a wide range of exceptional benefits such as:

- Supports in reducing environmental pollution thereby impact on electricity generation.
- Increases the energy security
- Promote the local manufacturing industries,
- Distributed energy supply hence improved services for rural population
- Creates the job through EPC works
- Promote regional consultancy & engineering services
- Increased R & D

1.6 Limitations of Renewable Energy Projects:

Side by side, renewable energy has some limitations narrated as under :

- The amount of sun light or wind available on the earth's surface is variable at different locations, time of the day, seasons of the years and depends largely on the weather conditions
- The amount of sun light or wind speed reaching on the earth surface per given area is very small or less, so that a very large surface area needed to collect or generate use full amount of renewable energy.

1.7 The power of SUN:

The history of civilization evident that the sun is the oldest and **ultimate source** for all the energy sources whether it is solar, wind, tidal or any other, providing the light and heat on the earth billions of years, ultimately helps in sustaining life on the mother earth hence, it can be said that energy in almost all forms available on earth creates with the sun in numbers of ways. This is evident from the fact that all other natural resources are created by the SUN. Say, wind which is generated by the changes in temperature caused by the sun, the air flow is utilized for the production of energy. The rainfall is nothing but an evaporation of rivers, lakes and oceans caused by the sun. These rain falls

accumulates and transfer into rivers and stream of water, the down flow of water or stored water in dam can be utilized for the production of energy. The plants and trees through the process of photosynthesis absorbs energy from the sunlight, hence get its nourishment from the sun which ultimately utilized as biomass for production of energy.

The mastery of fire was discovered by lightening stroke, which produces source of light as well as heat, fire leads to use of biomass. During the ancient period about sixteenth century, the increasing number of populations rest on the fire and hence the consumption of wood by destroying of trees is increased causing shortages of wood at some part of the world. Consequent upon the acute shortage of wood, few countries like Britain has started switching over to the new source of fossil fuel called coal. The fuel oil, primary coal and natural gas called fossil fuel as such these are extracted from plants and animal material of biological origin mostly within the earth`s crust and is utilized as source of fuel. Gradually increase in energy uses initiated which emphasize the exploitation of various forms of energy resources in the pre-industrial economy era.

Until the second millennium BC (11th to 20th centuries), the utilization of these fossil fuel was not so explored. However as soon as invention for the utilization of fossil fuel is initiated, the exploration of fossil fuel had been started, this era in the history is termed as ``**Industrial Revolution``.** This industrial revolution is the turning point in the world for human being as this is the era at which the human being started use of machines for some of their works since, the deployment of animal, horses and human muscle power turned to mechanized or industrialized. So up till the industrialization, the energy requirements was less and the sun were the power full source to fulfill the need of heat & light during day time. The transportation and other works were fulfill with the help of animals where the human muscle are failed to perform that works. Later, the harnessing wind had been discovered and that was utilized for the purpose of sailing of boats for transportation. Further to this, the wind power is begun to utilize in wind mills to rotate water wheels for pumping of water to ground the grains. In the conquest of energy, the evolution of water and wind power gains the milestone in the form of energy.

Thus, history revealed that even in ancient times, all efforts were made to convert the available power of natural resources into usable form of energy by the use of primitive technological resources existing at that time.

1.8 Renewable energy scenario in India:

India has evident a record of continuous development in renewable energy. As far as installed Renewable Energy power projects is considered, the India ranked **Fifth Wind Energy project installed capacity, Fifth ranked in Solar Energy project capacity and Forth global position in overall Renewable Energy project capacity installed as of 2020``**

This envisages that the renewable project industry has grown up like anything in India and as a result of matured renewable energy industrial market the new age upcoming companies and government initiatives, the renewable energy projects no longer now limited to any peripheral sector. The testimony of renewable energy projects development envisaged in the growth figures. As per MNRE, ``the India has met more than 87000 megawatts (MW) of installed RE projects till the end of first quarter of 2020, which turns out to about 22 percentage of India `s installed capacity for power generation. While sunny days when the sun shines and wind flows, the renewable energy meets about 15 percentage of the India electricity demands, which turns out to more than 7.5 per cent``. However, so far as installed power capacity is concern, the present growth is not a bigger either and hence not complimentable. This is because side by side the renewable energy projects grow, the challenges also grows which ultimately resist the growth of the renewable energy projects – in fact, the project development becomes trickier and trickier.

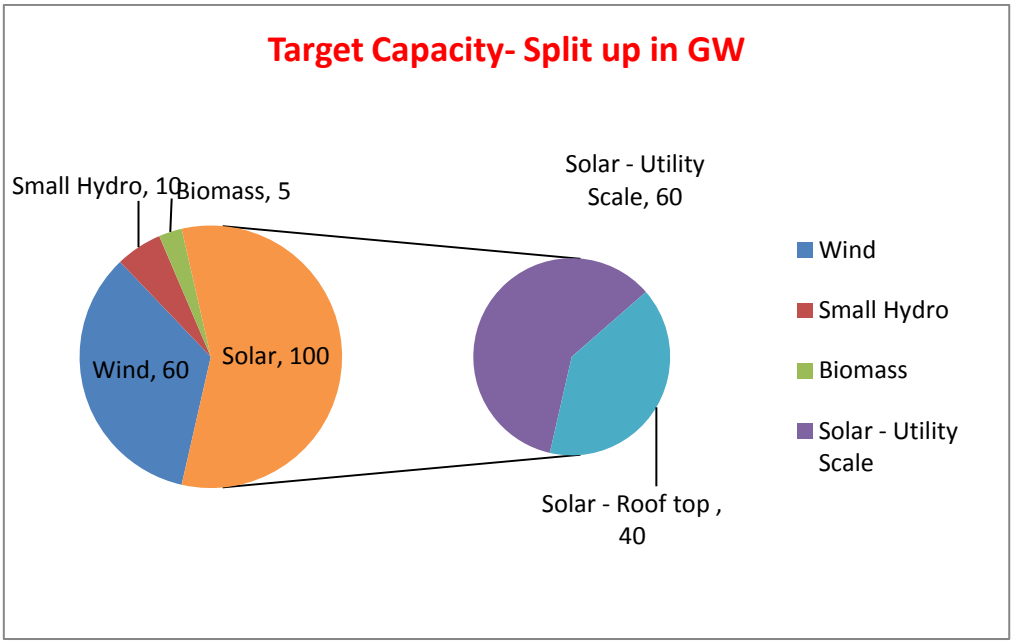
1.9 Renewable energy Target in India:

India has set a different target at different time based on the policy and development. The brief of solar energy target with introduction of various policies are shown as under:

Target set in national solar mission (JNNSM) 2009:	22MW
National solar requirement as per NTP amendment 2011:	34MW
Additional of state policy target as of 2016:	59MW
National solar target revised during 2015:	100MW

The Government of India during 2014-15, has set a target of 175 GW renewable power install capacity by 2022. The details split up of target capacity are shown as under:

Graph1.2: Split up of target capacity of 175GW up to 2022 in India



Further, India has enhanced ambitious target of installation of 450GW of renewable energy capacity by 2030.

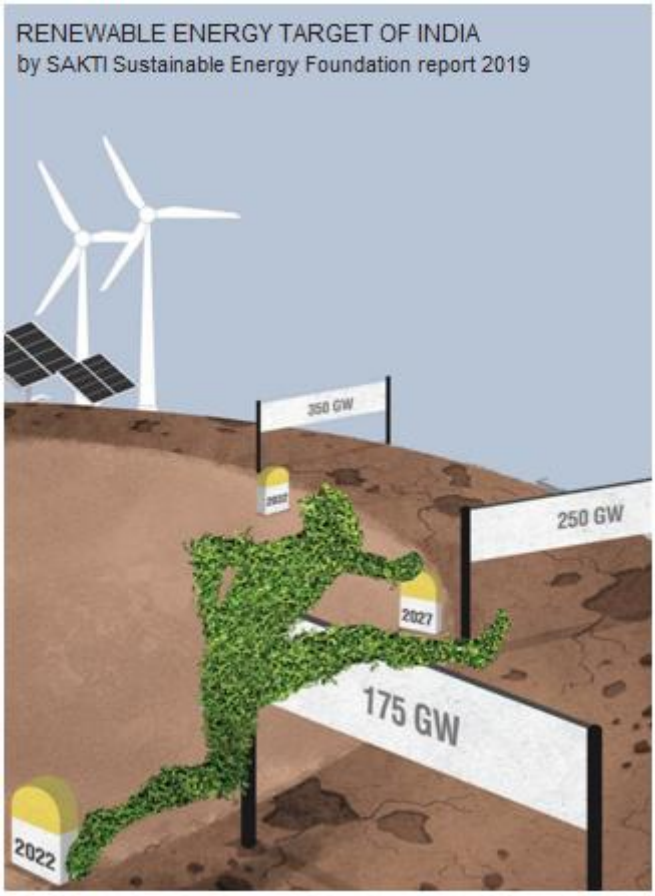
The focus on the solar and wind renewable energy projects, the target of 100GW solar renewable energy installed capacity as well as 60GW wind energy projects divided into year wise target and achievements from the declaration year of target to cumulative achievement up to March 31st, 2020 is narrate under Table:

Table1.1: year wise split of solar & wind target capacity in Gigawatts (GW).

Year	Target & Achivement	Cumulative achieved up to 31st March 2015	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	Cumulative achieved up to 31st March 2020	2021-22	Total (GW)
Solar	Target	3.0	2.0	12	15	16	17	17.5	82.5	17.5	100
	Achieved	3.0	3.10	5.55	9.36	6.55	6.22	5.27	39.87		
Wind	Target	24	3.2	3.6	4.1	4.7	5.4	6.1	45	8.9	60
	Achieved	23.45	3.40	5.50	1.87	1.58	2.04	1.50	39.20		

Source: MNRE & CEA Report

The NITI Ayog has published a report in 2015 and Shakti sustainable energy foundation report 2019 depicted in the form of picture represents the renewable energy project capacity installation capacity up to 2022.



1.10 Renewable Energy Potential in India:

As per (NITI Ayog , 2015) for India`s 2047 Energy Calculator for Renewable Energy ``the various forms of renewable energy has tremendous potential of RE project development, the potential of various renewable energy sources`` i.e. Solar Photovoltaic Projects and wind power projects both, at different level of effort are demonstrated the form of table.

(I) Trajectory of Solar PV Projects:

Earlier, solar power project was considered to be a high upfront cost in India as well as in World with number of project constraint. However, with the introduction of JNNSM under NAPCC, accelerated the growth of large scale solar PV projects particularly in the western part of India in the state of Gujarat & Rajasthan and in general in the southern part of India. Over and above, with the introduction of

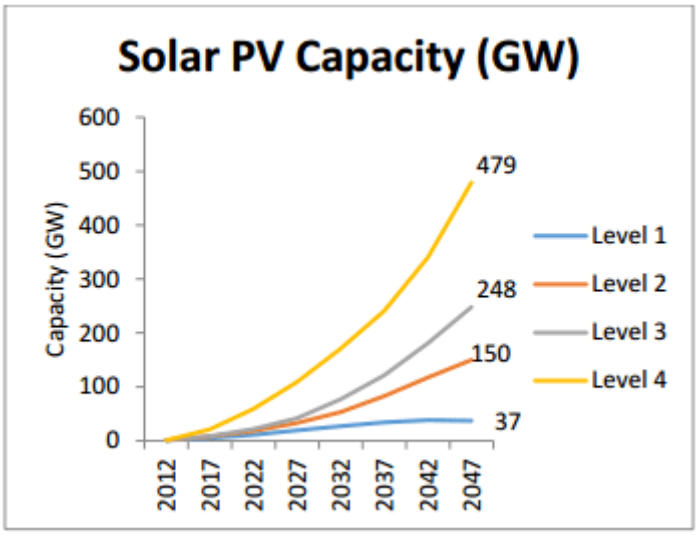
competitive bidding and the price discovery through e-reverse auction process further tends to reduce the cost of solar power projects and its production prices which supports the solar PV power projects going ahead in renewable energy sector.

Table 1.2 The trajectory scenario of solar power projects capacity during the year 2012 and year 2047 with different drivers & assumption along with different level of difficulties

Level	Assumption/level of difficulty	Trajectory Solar PV Project Capacity in GW	
		Year 2022	Year 2047
1	✓ Solar PV capacity addition assumes lesser than the predicted under NTP or JNNSM ✓ Cost of solar projects continue to be high ✓ Challenging variable solar power integration	11	37
2	✓ Solar PV capacity addition assumes as per prediction under NTP or JNNSM	179	150
3	✓ Cost of solar projects assumes to be gradually falling hence economically competitive ✓ Solar PV capacity addition assumes slightly higher than predicted under NTP or JNNSM	21.5 (cross 100GW by 2035)	248
4	✓ Assume no any barrier including land, evacuation constraint at all for the growth of solar PV projects ✓ Further assume sharp fall in solar PV prices ✓ Assumes availability of reliable smart grid, forecasting scheduling and dispatch of renewable energy power, energy storage system etc ✓ Meeting RPO as per target MNRE / state	58.94 (cross 340GW by 2042)	479

For easy understanding the said data is presented in the form of graphs as under:

Graph-1.3: Trajectory of Solar PV project capacity at different level of difficulty 2012-2047



Source: NITI Ayog 2015 Report

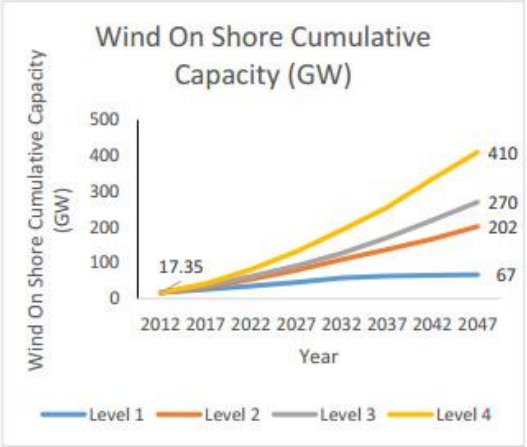
(II) Trajectory of Wind power Projects:

In India wind power projects development was initiated well in advance, say since early 90`s, which accounts to mainstream of renewable energy projects in India with developments largely at southern & western part of India, particularly in five leading states of Tamil Nadu, Karnataka, Maharashtra, Gujarat and Rajasthan. As per the GoI declaration, the target of onsite wind power projects of 60GW. However various studies indicates the actual wind potential is to the tune of more than 500-1000GW, it presumes that in spite of natural wind resources availability, the constrain and barriers restrict the development of wind projects.

Table 1.3 The trajectory scenario of wind power projects capacity during the year 2012 and year 2047 with different drivers & assumption along with different level of difficulties

Level	Assumption/level of difficulty	Trajectory Wind power Project Capacity in GW	
		Year 2022	Year 2047
1	✓ Wind capacity addition assumes lesser than the predicted under 12th plan or NAPCC targets ✓ Challenges of integrating variable wind power	35.8	67
2	✓ Wind capacity addition assumes as per 12th/13th plan prediction (32.35GW) ✓ Strengthening of evacuation & transmission system/planning of green corridor	54.35	202
3	✓ Wind power project capacity addition assumes slightly higher than predicted under 12th/13th Plan ✓ Undertaken effect of repowering of wind power projects and turbine capacity & increased hub height	62.35 (cross 100GW before 2030)	270
4	✓ Assume no any barrier including land, evacuation constraint at all for the growth of wind power projects ✓ Further assume sharp fall in wind projects prices ✓ Assumes availability of reliable smart grid, forecasting scheduling and dispatch of renewable energy power etc ✓ Energy security considered in energy planning	83 (reaches 300GW by 2040)	410

Graph-1.4: Trajectory of Wind power project capacity at different level of difficulty 2012-2047



Source: NITI Ayog 2015 Report

(Section-B)
Industrial Profile

1.11 Introduction:

Since last decades, the demand of the power has been growing. With this growing demands of electricity, the development of renewable energy projects including solar & wind power project are also growing but not at par with the renewable power requirements due to their challenges, barriers, weakness and threats involved in the renewable energy projects, mostly related to the renewable energy business markets. However, besides this factors, the India`s major strength today and going forward is that India is blessed with fairly high solar radiation with around more than 300 sunny days as India is located on the sunny belt of the world, which makes the region very appropriate for harnessing solar renewable energy source. Over and above this, India is endowed with fairly high wind potential, for harnessing the wind power also. Hence, the renewable energy projects potential is high and mostly untapped.

In order to tap India`s renewable energy potential fully over the next coming years, India will requires the new initiatives from central as well as State governments – beyond the policy and incentive programmes currently in place, which support the active participation and engagement of all renewable energy projects industrial sector – stake holders including developers, EPC agencies, policy makers, grid operators, IPP`s, research & development institutions, public & private financial institutions, consumers & related all.

With the given backdrop of challenges and strength, the government of India Ministry of Power, has constituted a full time ministry called Ministry of New & renewable Energy (MNRE) with supportive steering committee and Ayog for analysis, assessment and practical as well as approachable policy framework.

1.12 History of MNRE:

Constitution Provision related to electricity:

``Electricity`` is a concurrent subject at entry 38 in List III of the seventh Schedule of the Constitution of India. Hence central as well as state actors can both legislate on the Indian power sector. However, in case of duplication, central legislation prevails.

Ministry of New & Renewable Energy (MNRE) (www.mnre.gov.in):

MNRE is a nodal ministry of the central government deals in all the matters related to new and renewable energy and executing the function of deployment & development of renewable energy for supplementing the energy demands of the nation. The responsibility of MNRE is significantly increased during a recent due to growing need of the alternative energy.

Since 1970, there was no concept of energy self-sufficiency, however on the wake of two major oil crisis leads to uncertainties of oil supply causing adverse effect on economic situations of western countries and consequently sudden oil price increased identified the major drive of new and renewable energy at national level which create the birth of **``Commission for Additional Sources of Energy`` (CASE)** established in the Department of Science & Technology in March 1981. The commission was established to carry a responsibilities of formulation of energy policies, its implementation, and development of new and renewable energy alongside the intensifying the Research & Development responsibilities in the energy field as well. In 1982, commission is turned into a new Department called **``Department of Non-conventional Energy Sources`` (DNES),** which incorporated CASE, created in the then Ministry of Energy. Again with understanding the importance of new and renewable energy, in 1992, DNES turned to the **``Ministry of Non-conventional Energy Sources`` (MNES).** The same ministry in October 2006, was re-christened as the **``Ministry of New and Renewable Energy`` (MNRE).** Thus, India is the only country in the world which has a dedicated ministry of renewable energy.

MNRE is the nodal ministry for all matters relating to New and Renewable Energy covering scope of renewable energy projects:

- Solar Energy
- Wind Energy
- Mini hydro power
- Bio-mass, bio waste
- New energy sources such as Hydrogen, geo thermal, tidal power etc and Co-ordinating ministry for Bio-fuel policy and R & D.

For promotion, development, co-ordination and financing of renewable energy projects, the ministry is having following five specialized technical & financial institutions:

1) **National Institute of Solar Energy(NISE):**
   - Converted 25 years old Solar Energy Centre (SEC) to NISE in September 2013
   - An Autonomous Institution
   - Located in Gurugram, Haryana
   - Apex national R & D institution in the field of Solar Energy
   - Assist ministry in implementation of National solar mission, R & D, technology, training & skill development, consultancy & related works.
2) **National Institute of Wind Energy (NIWE):**
   - Set up in Chennai, Tamilnadu in the year 1998
   - an autonomous R&D institution
   - Apex national R & D institution in the field of Wind Energy
   - Dedicated knowledge base institution for research, technology, training & skill development in the spectrum of wind energy
3) **Solar Energy Corporation of India (SECI):**
   - Established on September 2011, incorporated as a section-25 (not for profit) company under the Companies Act, 1956
   - Dedicated Central PSU to the solar energy sector located at New Delhi
   - Facilitate for implementation of JNNSM and achievement of targets set therein

4) **Sardar Swaran Singh National Institute of Bio-Energy (SSS-NIBE):**

- an autonomous R&D institution, located in Kapurthala (Punjab)
- A Global Centre of Excellence in the Bio-Energy, Biofuels & synthetic fuels
- Facilitate R & D, design, technology standardization and demonstration projects
- Development of hybrid / integrated energy systems,
- Facilitate training and human resource development including up to postdoctoral research.

5) **Indian Renewable Energy Development Agency (IREDA):**

- A Non-Banking Financial Institution formed during March 1987
- Act as Executive Agency for new & renewable source of energy (NRSE) programme
- Facilitating term loans for promotion & commercialisation of renewable energy projects.
- Financially assisted by Government of Netherlands, World Bank, Asian Development Bank (ADB), Danish International Development Agency (DANIDA)

1.13 State Nodal Agencies:

The MNRE has established state nodal agencies in union territories and different states of India specifically for bearing the responsibilities of promotion, development, co-ordination and growth of renewable energy projects in the respective states. It covers the promotion & development of private sector projects as well, by means of providing required clearances, facilitate in allotment of land, registration and approval renewable energy projects in their states etc.

1.14 Institutional Structure– Central level:

Central Electricity Authority (CEA) (www.cea.nic.in):

CEA –established as a part-time body in 1951 and full time body in 1975, constituted under Electricity Act to perform statutory function of providing support to Ministry of Power for formulating policies, National Electricity Plan every five years for optimum utilisation of available renewable resources

in the country. The other duties & function includes finalising technical standards & regulations, to carry out project monitoring, creating data base, promote R & D and state-of-the art technology in the power sector.

Central Electricity Regulatory Commission (CERC) (cercind.gov.in)**:**

CERC is a statutory body constituted under the provision of erstwhile Electricity regulatory Commission Act 1998 and continued under Electricity Act 2003, Responsibilities to discharge includes mandatory functions of regulation of tariff for generation, inter-state transmission & sale of electricity controlled by central government and intra-state, adjudicate up on disputes for the same, specify grid standard, fixing power trading margin, and other advisory functions of formulation of NEP, tariff policy and promotion of investment, competition, economy, efficiency in electricity industry.

Forum of Regulators (FOR) (forumofegulators.gov.in):

FOR constituted in 2005 in pursuance of the provision under Electricity Act, 2003, consisting of chairperson of CERC as the chai person of FOR and chairpersons of SERC`s. FOR discharges the functions of analysis of tariff orders of central & state commissions, harmonising the regulations in power sector, formulating standard of performance, takes measures for protection of consumers, promotion of competition, economy, efficiency in power sectors.

Central Generator Utility (NTPC) (www.ntpc.co.in):

NTPC – largest power generating company in India, incorporated on 1975, with prime aims is to be the world`s largest and best power producers. Commensurate with the India`s growth challenges, NTPC embarked up on the ambitious plan of developing the green field power projects including large utility scale solar and wind power projects at various areas of the country. NTPC plan to a significant project capacities of renewable energy portfolio to the tune of 32GW capacity up to 2032.

Central Transmission Utility (CTU): PGCIL (www.powermin.nic.in):

The Power Grid Corporation of India Limited (PGCIL), the CTU of the national and a `Navaratna` company operating under the Ministry of Power,

incorporated during 1989 and engaged in providing transmission system for evacuation of power and bear the responsibility for planning, implementation, establishment and operation of national & regional power grid / Inter-state transmission system (ISTS) to facilitate transfer of power within & across the region with reliability and economically.

Northern Regional Load Despatch Centre: (NRLDC) (www.nrldc.in)

The integrated operation of national & regional power system is operated by **Power System Operation Corporation limited (POSOCO),** constituted in 2009 to execute the power management functions of PGCIL, Further, separate company is formed in 2017 entrusted the functions of load despatch. **T**he main functions involves supervision, control, planning, co-coordinating & implementation of infrastructure required for smooth operation and functioning of national Load Despatch Centre (NLDC) and all five Regional Load Despatch Centre (RLDC)

Indian Energy Exchange (IEX): (www.iexindia.com):

IEX operating since 2008 and regulated by CERC. IEX is the largest emerging nationwide automated trading platform in India for physical delivery of Renewable Energy Certificate (REC) and Energy Saving Certificate (ESCerts) and trading of electricity. The trading platform enables efficient electricity price discovery with transparency of Indian power market.

1.15 Institutional Structure – Gujarat State:

Energy & petrochemicals Department GoG (www.epd.gov.in)**:**

Responsibility includes overall planning & budgeting for development, promotion of electricity including renewable energy in the state of Gujarat. Assist central government for adoption and promotion of policies enacted by GoI and achievement of government target given time to time.

Gujarat Electricity Regulatory Commission (GERC) (www.gercin.org) **:**

The GERC is a statutory body constituted in 1998 as per the provisions of Electricity Regulatory Commissions Act 1998 and continued in the Electricity Act 2003. GERC carry the responsibility of regulating the electricity sector of

Gujarat with determination of tariff of electricity and grant of licences at intra-state level and effectively promoting the renewable energy projects, determination of tariff, specify the grid codes, adjudicate upon the disputes between customers, licensees, generating companies, assisted by various committee formed like State Advisory Committee, the Co-ordination Forum of all the power utilities of the State and the Consumer Grievance Redressal Forums who address the issues relating to both consumers and electricity companies. GERC has been taking effective steps in promoting renewable sources of energy.

Gujarat Energy Development Agency (GEDA) (www.geda.gujarat.gov.in)

GEDA is the premium organization and a state nodal agency for the Ministry of New and Renewable Energy. The responsibility covers the promotion and development of long term renewable energy economically and commercially and implementation of policies related to renewable

Gujarat Power Corporation Ltd: (gpcl.gujarat.gov.in/) **:**

A state Government Company promoted by Government of Gujarat, incorporated in June 1990 under the companies Act 1956. Company is designated nodal agency for development of Solar Park by acquisition of lands for solar park, providing facility of required resources like water, transmission facilities, and evacuation of renewable power from solar Projects.

Gujarat Urja Vikas Nigam ltd (www.gseb.com)**:**

State owned Government of Gujarat Company engage for procurement of bulk power, sale of electricity to distribution companies of Gujarat and trading licensee for intra state power trading. Execute the power purchase agreement with the generator both PSU and private renewable energy projects as well.

Generation Utility:

State owned generation utility as Gujarat State Electricity Corporation Ltd (GSECL), came in to existence after unbundling of Gujarat Electricity Board (GEB) during 2005 after electricity Act 2003 involved in the development of

new conventional power projects including renewable energy projects at large scale both wind and solar projects for generation of electricity.

Transmission Utility:

State owned transmission utility (STU) GETCO established in 1999 responsible for construction, operation & maintenance and transfer of power from generator / renewable energy projects to the DISCOM or to the industrial consumers. Company has built up programme of network capacity addition, transmission asset management, state grid stabilization & operation, smart grid operation for transmission of power from renewable energy projects

State Load Despatch Centre (SLDC) (www.sldcguj.com):

SLDC, the apex body to ensure the smooth integrated operation of state power system, came into operation since 1069. The responsible for optimum real time operation & management of power flow within the state of Gujarat in accordance with the contract entered into with power generating companies & distribution licensees, supervision, & control of real time grid operations as well as monitoring the quality of electricity supply as per state grid code & grid standards, supported by four Area Load Despatch Centres (ALDCs)

DISCOMs:

Gujarat has four public owned electricity distribution companies incorporated under the companies act 1956 in 2003 as a result of unbundling of erstwhile Gujarat Electricity Board pursuant to Power Sector Reforms initiated by Central & State Governments. All the four DISCOMs are wholly-owned subsidies of GUVNL and have one privately owned company Torrent Power, Shoulders the responsibility of supply of quality and uninterrupted electricity to consumers of Gujarat, metering and billing of renewable energy electricity.

1.16 Intuition`s Functional Framework for Renewable energy in India:

Table 1.4 Institutional framework

Functions	Institutions / body		Key Role & Responsibilities
	Centre Level	State Level	
Policy Making	Ministry of Power & MNRE	State Government, Energy & Petrochemicals Department	MoP: Future planning, policy formulation, Promoting projects investment decision, implementation & monitoring of power projects, HRD & training, enactment of legislation in respect of power Project, generation, transmission and distribution in the country. MNRE: Nodal ministry relating to new and Renewable Energy
Planning & Advisory	Central Electricity Authority	State Government	CEA: Overall planning & development of power sector in the country. Advise and assist Central/state Government on matters relating to electricity generation, transmission, distribution, trading and utilization.
Regulatory	Central Electricity Regulatory commission, Forum of Regulators	State Electricity Regulatory commission, State Forum of Regulators	Planning & formulation of National Electricity Policy and Tariff Policy, Promotion of competition, investment, efficiency and economy in electricity industry & projects
Generation	Central Generator NTPC	State PSU Generators, IPP,CPP, GIPCL	Project development & generation of electricity
System Operation	National Load Despatch Centre, Regional Load	State Load Despatch Centre, Area Load Despatch Centre	NLDC: Apex body at the national level, SLDC at state level to ensure integrated power system operation in the country/state responsible for real time operations & grid

	Dispatch Company		control and despatch of electricity in accordance with the Indian Electricity Grid Standards and the Grid Code.
Trading	Trading Licensees	GUVNL, State Trading Licensees	Trading of generated electricity
Transmi-ssion	Central Transmission Unit (CTU), Power Grid Corporation of India (PGCIL), Private Transmission Utility	State Transmission Unit (STU), GETCO, Private Transmission Utility	Transmission of generated electricity
Distributio n	Distribution Licensees & Private Licensees	Distribution Licensees & Private Licensees, Torrent, Kandala Port Trust	Distribution of generated electricity

1.17 List of leading Stake holders in Renewable Energy projects:

Table 1.5 List of leading stakeholders

Name of Stockholders	Name of Stockholders
• Tata Power Solar System Limited • Adani Green Energy • Azure • Greenko Energy Holding • Acme Solar Pvt Ltd • Engie Green Energy • Jinko Solar • Suzlon energy Ltd • Inox wind limited • Regen power tech Pvt Ltd • Orient green power Ltd • Enercon India pvt ltd • Gamesh Wind turbine Pvt Ltd	• L & T Renewable Energy • Sterling & Wilson • Mahindra Sustain • NTPS Renewable Energy • Renew Solar Power • BHEL Renewable Energy • Vikram Solar • Gujarat Energy Research & Management Institute (GERMI) • RPG group • Waaree Energies • Kosol Energies • Refex Energy Pvt Ltd

1.18 Stake holders – Role in Renewable Energy projects:

Table 1.6 Stake holders – Role

Stake holders	Role
Project Owner	The owner of the equity for the project and beneficiary in the generated income.
Project Developer	The owner of the project development, responsible for installation of the complete project & beneficiary in profit
EPC Contractor	Responsible for Engineering, Procurement & Construction of the Renewable Energy Project.
O & M Contractor	Responsible for Operation f the project after commissioning
Manufacturer	The manufacturer of equipment's used in the projects
Supplier	The Supplier of the equipment's & manpower for the projects
Land Owner	The Owner of the land on which project is established and get sharing in profit or lease rental from project developer
Power off-taker	The utility or electricity company who purchase power generated from the project on the base on power purchase agreement & responsible for payment to project developers.
Investor	The bank or institution who invest in the project and get sharing in profit / return on onvestment or certain amount of returns from project
Financier	The bank, institutions provides part of the fund on debt finance for the projects and get return as interest
Consultant	Who act as co-ordinating agency between developers & EPC contract & support for the project and obtain some fixed amount in lieu of services provided.
Policy maker	To collect information from various resources, stake holders & researcher to prepare set of policies best suitable to promote the renewable energy projects.
Regulator	Regulating the tariff through transparent procedure, development & promotion of RE projects and protection of consumers/ stake holders.
R & D Institutions	Research for the optimum technology in renewable energy projects, recommendations for development of projects
Academicians	Awareness & educate regarding the renewable energy project developments & technical knowhow.

1.19 Regulatory frame work for RE in India:

Ministry of Law & Justice , GoI, (2003) The Government of India has formulated support mechanism for Renewable Energy power development in the early 1990s. However, the first national and major legal regulation was the Electricity Act (EA) of 2003.

Electricity Act 2003: The abstract of the Electricity Act 2003: *"The electricity act consolidate the laws pertains to generation, transmission, distribution, trading and use of electricity and particularly for supporting for development of electricity industry, promoting competition, protection for the interest of consumers and electricity supply to each areas, competitive electricity tariff, transparent policies related to the subsidies, promoting sustainable policies, establishment of Central Electricity Authority, Regulatory Commissions and Appellate Tribunal for matters related to electricity.*

The EA 2003 **Ministry of Law & Justice , GoI, (2003)** has establish numbers of enabling provisions to promote and develop Renewable energy sources available in country, the major provisions are narrated here under:

- *Section 3 (1), - ``GoI may, prepare & update the National Electricity Policy (NEP) and National Tariff Policy (NTP), in co-ordination with the State Governments to develop the Indian electricity system depending on optimal utilisation of resources particularly renewable energy sources.``*
- *Section 3(3) -`` The government of India shall in co-ordination with the State Governments, and the Authority updates or modify, the National Electricity Policy and National tariff policy as stated under section 3(1).``*
- *Section 4 - ``The central Government may, in co-ordination with the State Governments, establish NEP allowing the stand-alone systems particularly related to renewable energy sources for distributed areas.``*
- *Section 61 (h) – ``State Electricity Regulatory Commission shall review, updates and finalise the terms and conditions for the determination of the Tariff for co-generation and electricity generation from the Renewable Sources of energy as per guidelines of Central Regulatory Commission.``*

- *Section 86(1) (e), ''The State Regulatory Commission may encourage electricity production from renewable energy sources with provision of required connectivity with the transmission system and facilitate the sale & purchase of electricity generated from renewable sources of energy, to any of the consumers and define the obligation of renewable power consumption from among the gross electricity consumption``*

Thus, it is evident from above that the Government of India held responsible for **implementing the** national electricity policy and national tariff policy **enabling as per the legal provision under Electricity Act 2003** in co-ordination with all the State Governments so as to optimally utilize the renewable sources of energy.

National Electricity Policy 2005:

Provisions under Section 3 of EA 2003, where the Central Government published NEP 2005 during February 2005. Particularly, **Clause 5.12 of said policy** outline various provisions related to promoting, developing and harnessing of renewable energy sources.

The main salient features are as under:

- *Actions for fast promoting generation of electricity based on renewable sources of energy*
- *All efforts to be made for reduction of the capital cost of renewable sources of energy projects.*
- *Enhancing competition to reduce cost of electricity generated with the usage of renewable sources of energy projects*
- *Sufficient encouraging steps to be taken to develop renewable sources of energy projects related technologies for sustainable development of renewable sources of energy.*
- *All State Electricity Regulatory Commissions shall provide adequate steps for providing of connectivity with transmission system grid and define the obligation for purchase & consumption of certain percentage of power generated from the renewable sources of energy.*
- *Step by step percentage of share for generation of renewables power is to be enhanced..*

National Tariff Policy (NTP) 2006: Further, provisions under Section 3 of EA 2003, where the Central Government published National Tariff Policy 2006 during January 2006. Particularly, **Clause** 4 of the NTP addresses various provisions to promoting, developing and harnessing of renewable energy sources. National Tariff Policy briefly defines the role of State Regulatory Commissions for providing the system to promote, develop and harness the renewable sources of energy with scheduled timeframe so as to implement the same.

The salient features of TP are as under:

- *Certain minimum percentage of renewable power to be purchase is to be made applicable latest by April 1, 2006 as per the Section 86(1)(e) of the EA2003*
- *Competition to be encouraged among the renewable power projects developers by determining the preferential tariff by each state regulatory commission.*
- *Purchase of renewable energy power by distribution licensee through competitive bidding process.*
- *Solar specific renewable power obligation (RPO) initially from a minimum of 0.25% 2012-13 to 3% by 2022 (Amendment in 2011)*
- *Increasing Solar renewable power obligation (RPO) by 8% up to 2022 (Amendment in 2016)*
- *Waiver of interstate transmission charges and transmission losses for Solar & Wind power projects up to 2022*
- *Introduction of Renewable Generation Obligation (RGO).*

Integrated Energy Policy 2006:

- *Integrated Energy Policy is introduced by Planning commission of India in the year October 2006*
- *In order to promote renewable sources of energy, focuses on the shift towards performance incentives from capital subsidies.*
- *Focus on development and adoption of an integrated energy framework with long-term vision and time-bound planning with implementation to help the development of renewable energy projects.*

- *Supports the investors by understanding & resolving the issues of potential investor particularly related to volatile policy and envisaged risk associated with renewable energy projects.*

National Action Plan on Climate Change 2008:

- *Set aside the target for Renewable Energy procurement at National level : 5% of total procurement of electricity from transmission grid in 2010, which is to be enhanced by 1% annually up to 10 years i.e. increased it up to 15% by 2020*
- *Even though each state regulatory commission shall have to target at higher leve.*
- *In order to promote renewable energy projects, concerned government authorities shall issue Renewable Energy Certificates (REC) for purchase of renewable power in in excess of the defined target level.*
- *In order to fulfil the shortage of renewable power purchase by the responsible utilities, the trading of Renewable Energy Certificates (REC) in the power exchange is to be envisaged, so enable utilities to meet the required power purchase obligation.*
- *Increasing the capacity of Renewable energy project power generation from 25oooMW to 45000MW by FY 2015.*

Jawaharlal Nehru National Solar Mission 2010 (JNNSM): The JNNSM launched in January 2010, set the ambitious target of developing 20 Giga watts of solar power projects connected to grid by 2022.

- *Targets for reduction of cost for solar renewable projects power in the nation to achieve grid parity.*

National Tariff policy amendment 2011

- *All state regulatory commission may defined separate Renewable power purchase obligation for procurement of renewable power by the Obligated Entities from Solar renewable energy source.*
- *Increasing the Solar renewable power purchase obligation up to 0.25% by the end of 2012–13 and further increase up to 3% by2022*
- *Procurement of power from renewable energy sources among the various states across India more or less to the equal proportion.*
- *The given target to be achieved with the support of Renewable Energy Certificate (REC) Mechanism.*

1.20 Renewable Energy Policy Initiativeness in India:

Table 1.7 Renewable Energy Policy Imitativeness in India

Year	Instrument/ initativeness	Key features
1992	Creation of MNRE	Enactment of full fledge Ministry of New & Renewable energy
1994	MNRE Policy & RE tariff guidelines	MNRE Introduced RE tariff guidelines – states to purchase RE power at Rs 2.25/kWh with 5% annual escalation with base year 1993, this tariff rate offered relatively higher price for RE the than what was prevailing and thus triggered development of RE sector.
1995	Introduction of Accelerated Depreciation	Introduced 100% AD for promotion of wind projects (altered to 80% AD in 1999). This initiative led to the successful commercial development and involvement of private sector in wind equipment manufacturing as well as its application.
2003	Electricity Act 2003	Recognizes the role of RE for supplying power to the utility grid as well as in standalone systems. Provides an overall framework for preferential tariff and quotas for RE
2004	Preferential Tariffs for RE from SERCs	Post enactment of the EA-2003, preferential tariff mechanisms determined by the appropriate commissions, is adopted across the states for development & promotion of RE.
2005	National Electricity Policy 2005	Focus to exploit feasible potential of RE resources to increase the share of RE power, promote competition, reduce capital costs, procurement of RE power by distribution companies through competitive biddings and promotion to private sector participation.
2006	National Tariff Policy (NTP), Introduction of Renewable Purchase Obligation (RPO)	Directed appropriate SERCs to fix a minimum percentage of purchase of energy consumption from RE sources (RPO) considering the availability of resources in the region & its impact on retail tariff which created a demand side stimulus for RE development.
2006	Integrated Energy Policy 2006	Suggested a path to fulfil energy requirements in an integrated manner.

		Emphasize on RE power projects development and set specific targets for capacity addition through sources of RE projects.
2008	National Action Plan on Climate Change (NAPCC)	NAPCC advised for setting up of RPO's at 5% of total grids purchase for 2009-10 be increased by 1% each year up to 10 years starting from 2009-10 to reach 15% RE penetration by 2020
2009	Generation Based Incentives (GBI)	Introduction of Generation Based Incentives to promote generation of renewable energy projects
2010	Jawaharlal Nehru National Solar Mission (JNNSM)	JNNSM targets 20,000 MW of grid-connected solar power capacity and 2,000 MW of off-grid solar power capacity by 2022.
2010	Renewable Energy Certificate (REC) regulation	For meeting the RPO (renewable purchase obligations) by designated entities, REC mechanism is introduced in which trading of sale and purchase of solar and non-solar renewable energy certificates are takes place in an open market.
2014	Scheme for development of Solar Parks and Ultra Mega Solar Power Projects (UMSPP)	Set up of at least 25 solar parks and UMSPP targeting over 20GW od solar power projects within a 5 years span starting from 2014-15 with support of Central Financial Assistance (CFA)
2015	Revision of National RE capacity addition targets till FY 2022	India's RE target revised to 175 GW (100MW solar, 60MW wind, 10MW Bio mass and 5 MW small hydro power) capacity by year 2022
2015	RE in priority sector	Renewable Energy sector is included as priority sector under the RBI norms so that banks are obligated to earmarked certain percentage of lending to RE sector to encourage the renewable energy projects
2016	Amendment to National Electricity Tariff Policy, 2016 –National RPO trajectory	NETP 2016 – mandates solar RPO targets of 8% (excluding hydro power) Renewable Generation Obligation (RGO) on conventional power projects No inter-state transmission charges for wind & solar power up to 2022.

2016	Repowering of wind energy project policy	In order to optimally utilise the wind resources and lands, the wind project capacity less than 0.5MW is encourage for repowering with providing of additional interest rate by IREDA
2017	Tariff base competitive bidding process	To promote competition and reduce cost of renewable power. For standardisation & uniformity in the process and a risk sharing framework between various stake holders, encourage investment, enhanced bankability of the RE projects and profitability for the investors involved in RE projects.
2017	Enhancement of solar parks & UMSPP	Solar park (500MW & above) & UMSPP park capacity enhanced to 40GW to be set up by 2021-21, supports various states & UTs ti facilitate common infrastructure like transmission system, water access, road connectivity, communication network & clear lands to speed up projects on large scale with support of Central Financial Assistance (CFA)
2018	Waiver of intra-state transmission charges	Waiver of intra-state transmission charges and losses on transmission on generation of electricity by renewable energy projects. The same is extended time to time.
2018	National Wind-Solar hybrid policy	Provides a framework for promotion of large grid-connected wind-solar (PV) hybrid system for efficient utilisation of infrastructure & land, to reduce variability in RE power generation & better grid stability.
2020	Continuation of Must Run Status & curtailment as deemed generation	Grant of `Must Run` status to renewable energy power projects mean evacuation of power generated from solar & wind power projects should not be curtailed, but for grid safety reason would amount to deemed generation.

Source: compiled from various sources

1.21 Financial / Fiscal policy Incentives for promotion of RE:

Table 1.8 Financial / Fiscal policy Incentives for promotion of RE

Sr No	Policy Instruments	Responsible Agency	Objective	Applicability
1	Capital Subsidy	Ministry of New & Renewable Energy (MNRE)	To reduce upfront investment cost	To pilot/ demonstration projects in the field of Renewable Energy
2	Interest Subsidy	Ministry of New & Renewable Energy (MNRE)	Subsidy on interest to bring down capital cost thereby reduce life cycle cost of projects	To pilot/ demonstration projects in the field of Renewable Energy
3	Tax Holidays / Direct Tax exemptions	Ministry of Finance	Provide incentive to RE based power generating projects	Pilot/ demonstration wind, small hydro and bio mass project up to 2006, continue for solar power projects
4	Indirect Taxes - Cess, Exemption from Taxes & Electricity Duty, Exemption from Import/ Concessional Excise & Custom Duty	State Government , MoF	Reduce grid parity	For solar & wind projects
5	Accelerated Depreciation (AD)	Ministry of Finance, state Government	Reduce grid parity	AD only for wind and solar Technology
6	Generation Based	MNRE	To incentivize for production of	Solar & wind projects

	Incentives (GBI)		power (Production subsidy)	
7	Central Financial Assistance (CFA)	MNRE	Encourage & promote renewable energy projects & RE parks.	For solar & wind park projects development
8	Viability Gap Funding (VGF)	MNRE	To sustain upfront project cost. (certain %age of project cost or Amount /MW capacity, whichever is lower	For specific project schemes and large scale solar & wind projects development
9	Budgetary Support /Grant for R & D and Demonstration /pilot Projects	MNRE	Inviting public investment to showcase technological development in the field of RE	Renewable Energy Projects development
10	RE fund	State Government & State Nodal Agency	Low cost fund to promote RE investment	Renewable Energy Projects investment
10	Carbon Trading	MoEF &CC	Financial incentive & promotion of RE/clean power generation projects	Renewable Energy Projects

Source: compiled from various sources

1.22 Regulatory Incentives for promotion of RE:

Table 1.9 Regulatory Incentives for promotion of RE

Sr No	Policy Instruments	Responsible Agency	Objective	Applicability
1	Feed in Tariff (FiT)/ Preferential Tariff	State Electricity Regulatory Commission (SERCs)	To assured price for RE projects, generation feeding into the grid	projects in the field of Renewable Energy
2	Renewable Purchase Obligation	State Electricity Regulatory	Promotion & encouragement for share of RE in power	Solar projects

	(RPO)/ Renewable Portfolio Standard	Commissio n (SERCs)	generation & distribution	
3	Renewable Energy Certificate	Indian Electricity Exchange (IEX)	Provide trading opportunity to RE based power generating projects	Renewable Energy Projects
4	Terms & conditions for determination of tariff	Central Electricity Regulatory Commissio n (CERC)	To assured price for RE projects, generation feeding into the grid	Renewable Energy Projects
5	open access Regulation, development of transmission networks to connect RE projects, and wheeling & banking, Third Party Sale	State Government / SERCs	Facilitate transmission of renewable energy projects power generation into grid and sale of power to third party	Renewable Energy Projects

1.23 National plan wise solar growth:

Planning Commission, (2017) & (Karan Kapoor a, 2014) India has initiated five year plan (FYP) since the independence to programme the integrated economic development plan for the country. The five year plan is prepared by Planning Commission who is responsible for preparation, execution and monitoring the FYP. The first five year national plan was released in the year 1951and till India has completed 12th five year plan (2013-2017)

Growth during 1st FYP (1950-55):

During this period, the conventional sources were the main source of electricity generation with the total installed capacity consisting of only 2.3 GW by 1950.

2nd FYP (1955-60):

Again the major electricity sources were conventional but increased in total installed capacity to 3.420GW and 5.700GW at the end of the year 1955 and 1960 respectively.

3rd FYP (1961-66):

It was the phase during which the developed countries of the world think about the technology of solar sources for generation of electricity. Off course the electricity demand increases simultaneously the total installed capacity was also increased to the tune of 10.170GW through the conventional sources of energy.

4th FYP (1969-74):

During this period no further growth or initiation found regarding tapping of solar energy. However the development of small hydro, tidal and geo thermal power was initiated. The total installed capacity rose to 18.456GW at the end of plan

5th FYP (1974-79):

The government emphasis for the research and development of the nonconventional sources of energy like small hydro, geo thermal and tidal on priority and total installed capacity enhanced up to 1.3GW

6th FYP (1980-85):

During this plan, Department of Non-Conventional Energy Sources (DNES) established during September 1982 under the Ministry of Energy (MoE), with the sole objective of funding the research & development, demonstration of pilot projects in the field of renewable energy technologies (RET) including all important renewable energy sources like solar, wind, geo thermal bio mass with particularly addressed to the implementation of solar energy projects for meeting the electricity requirements of de centralised rural areas. Under this plan, Research & Development for high efficiency solar cell development programme was planned through Central Electronics Ltd (CEL)

7th FYP (1985-90):

7th FYP witnessed an historical technological development of Amorphous Silicon solar cell (ASSC) and manufacturing plant with 500KW capacity of module per annum with demonstrated cell efficiency of 13-15% is to be established by Bharat Heavy Electrical Limited (BHEL), a Bharat Ratna company of GoI.

8th FYP (1992-97):

The central government planned to electrify 10,000 remotely located villages with the use of decentralised solar photovoltaic energy sources by solar PV devices for the purpose of cooking and heating. Planned for development of 1750KW capacity of solar PV plant, solar pumps. Solar cooker and solar lighting.

9th FEP (1997-2002):

Government of India has promoted and initiated private sector participation in order to mobilize additional resources for generation, transmission and distribution. Under this initiative, the provision for independent renewable power developers were made and they allowed the right of wheeling the renewable power in the existing transmission lines of various State Electricity Boards (SEBs) with reasonably lower charges for third party sale of renewable electricity. Policy framed for permission of private renewable project developers to set up solar and wind power projects of any capacity.

10th FYP (2002-2007)

During the tenth plan, target for wind – 1.50GW, Solar power – 0.145GW, small hydro – 0.60GW, and bio mass -0.750GW was scheduled. Over and above, plan for village energy security was approved as a part of remote village electrification. A pilot solar pump project was promoted with the partial subsidy support from central and providing of soft loan from IREDA for balance of cost. Further, a target of 5MW de centralised solar PV project is planned to electrify the 4000 remote area villages. Also encouraged solar lantern, Solar PV pumps, Solar PV generators, solar water, air heating system and solar cookers.

11th FYP (2007-2012):

During this period there are tremendous pressures of climate change. India being a responsible developing country, under the National Action plan on climate change (NAPCC) launched Jawaharlal Nehru National Solar Mission (JNNSM) during 2010 promoted the solar energy in a large way to mitigate greenhouse gas emission and map a way for energy security by 2022. As a effort, the actual on grid & off grid connected solar capacity commissioned during the 11th plan ending on March 2012 reached to 0.940GW and 0.046GW respectively.

12th FYP (2012-2017):

The national solar mission during the 11th plan is the major initiative taken by Government of India for the promotion of eco-friendly energy along with sustainable development simultaneously addressing the issue of energy security challenges faces by country. This is the phase where the growth of solar renewable energy project has taken place for development.

1.24 Phased manner growth of Wind Power Project:

The wind power projects in India, grown up in almost three phases as under:

- Ist Phase: The growth of first phase of Wind project initiated with the assistance of subsidies and incentives declared by the Ministry of New & Renewable Energy (MNRE), Government of India during the period 1992-2002, resulting in addition of about more than 1.59GW of wind power project capacities. The subsidy provided in the form of state sales tax, full 100% accelerated depreciation and capital subsidy as well as Incentives in the form of third party sale of wind project power for captive consumers under open access with benefit of wheeling and banking with cost competitiveness.

- 2nd Phase: The launch of RPO (renewable Purchase Obligation) and FiT (Feed in Tariff) during the period 2002-2007 accelerated the growth of wind power projects resulting in addition of more than 5.47GW of wind power project capacities.

- 3rd Phase: With the introduction of incentive in the form of GBI (generation based incentive) and RECs (Renewable Energy Certificate) causes entry of IPPs (Independent Power Producers) during the period of 2007-2012 which resulted in topping up of more than 10.25MW of wind power project capacities in India

It is evident that since post-independence our country has witnessed number of initiatives and programmes under various five year plan to promote, develop the growth of renewable energy projects particularly solar energy projects and wind power projects however all efforts are not turned into realisation since the five year plans of 1950. The actual promotion and growth of solar and wind projects is actively initiated from the formation of national as well as state level specific solar policy during 2009 and ambitious initiative of JNNSM.

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